

# Optimization Using Decisions Tree and Linear Programming

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## Abstract

This study aims to optimize profit and satisfy the customer by meeting the schedule of a company that having fierce competition of selling furniture in to global market. In operating their production, the company has been faced by many obstacles, first, they need to decide which combination of products they should have, whether they must allocate their resources to produce common products, custom products, or combination of them. Common products only have 30% profit margin but need few numbers of human resources and less time to produce. Meanwhile, custom products have a 65% profit margin, but they need many more skillful human resources, trial and error, and longer time to produce. Using past data, we model the problem in to decision analysis and then continue with linear programming and sensitivity analysis. The results show that the company will gain 25% increase in net profit and 100% meeting the production and delivery schedule.

## Keywords

global market, competition, optimize profit, decision analysis, linear programming

## 1. Introduction

PT. GMS is a furniture company operating since 2003 in Sragen, Central Java. They became a PT on 2013. They sell all of their products to the buyer in Netherland. This buyer has a partnership with few furniture companies in Indonesia to supply their needs of furniture-with-a-wooden-base products as this buyer also owns many stores and showroom throughout Europe. Basically, there are 2 types of products produced by the company which are common products and custom products. Common products are products that has been made all the time, they have standardized size, color, etc. Meanwhile, custom products are products that can be ordered in a specific criterion with a limited amount of quantity.

As for the production process, it starts from transforming the raw material (Solid Log) into processed log (Sound Timber). After that, the sound timber is baked to form wood components that later on can be used to build the furniture. In addition, the company obtains its raw materials from Boyolali, which is around 1 hour – 1,5-hour distance from Sragen.

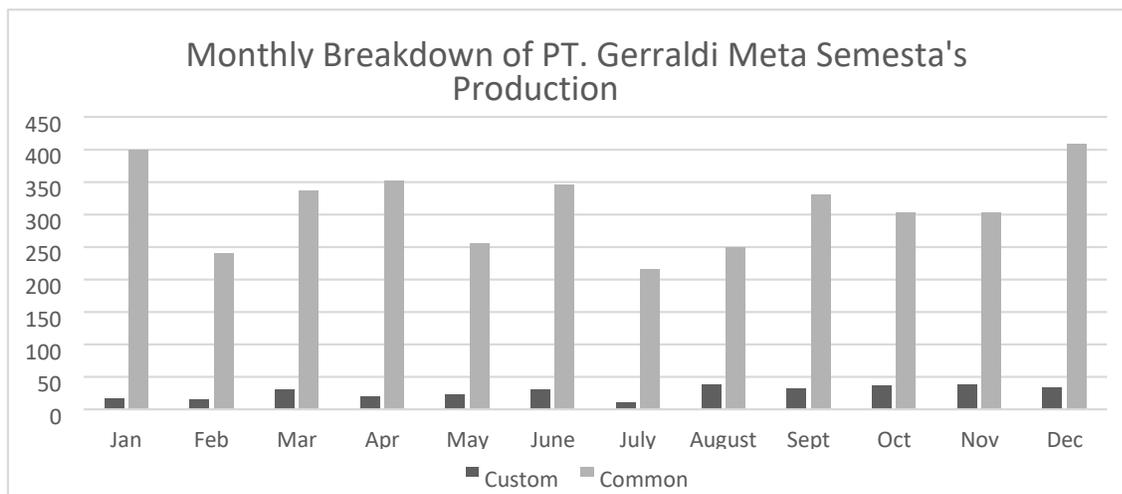
In operating their production, the company has been faced by many obstacles, first, they need to decide which combination of products they should have, whether they have to allocate their resources to produce common products, custom products, or combination of them. Common products only have 30% profit margin but need few

number of human resources and less time to produce. Meanwhile, custom products have 65% profit margin but they need many more skillful human resources, trial and error, and longer time to produce. Moreover, there are six types of products that dominate the sales of PT. GMS products which are Salontafel (Coffee Table), Hoektafel (Corner Table), Vitrine (Showcase Cupboard), Kast (Wardrobe), DRESSOIR, and EET (Dining Table).

The number of demand and production of PT. GMS are always the same, because the company has signed an agreement with the buyer for a year period, they have been working with this buyer since the beginning of the company. The current capacity is to produce 30 Custom Products and 300 Common products per month. Due to the fact that the buyer has a partnership with few different companies, it is very important for PT. GMS to focus on only taking orders and selling on what is really profitable and creating limitation for others (not accepting all orders without no further consideration).

PT. GMS productions for 2015 without the products' profitability analysis can be seen in Fig 1.1. With the research result, the company is expected to be able to reduce the production of products that has no significant effect on the company's profit and use the excess capacity to increase the production of products that give more contribution towards the company's profit.

Since each product has different needs of raw materials and constraints, PT. GMS also needs to be able to allocate the right amount of raw materials and human resource so the capacity can be maximized, and all orders can be shipped on time.



**Figure 1.1 Monthly Breakdown for PT. GMS Production's**

Furthermore, here are also some indications showing that by not fully understanding their capacity, what they need to produce and how many of them, etc, the company has not been able to meet with the buyer's deadline for several times. This case can cause PT. GMS to get penalty which is eventually can create significant loss for the company. Therefore, it is necessary to find the most profitable combination of products to be produced in order to generate the maximal profit (all common, all custom, or combination between them).

There are two methods that are used in this research. First, decision tree to help the company determining the most profitable product combination to produce. Second, linear programming to help the company producing to determine the most profitable products' quantity by combining the product's variation based on the company's limitation. The outcome resulted by the decision tree will be used as the objective function for the linear programming.

## 2. Literature Review

Measuring globalization is problematic, especially for historical comparisons. First, a country's interdependence must be measured indirectly. Second, when national boundaries shift, such as in the breakup of the former Soviet Union or the reunification of East and West Germany, domestic business transactions can become international transactions and vice versa. Nevertheless, various reliable indicators assure us that globalization has been increasing, at least since the mid—twentieth century. Currently, over 20 percent of world production is sold outside its country of origin, compared to about 7 percent in 1950. Restrictions on imports have generally been decreasing, and output from foreign— owned investments as a percentage of world production has increased. In almost every year since World War II, world trade has grown more rapidly than world production. However, in recessionary periods, global trade and investment contract even more than the global economy, such as a fall in world trade of 21 percent between April 2008 and May 2009.

At the same time, however, globalization is less pervasive than you might suppose. In much of the world (especially poor rural areas), people lack the resources to establish more than the barest connection with anyone beyond the outskirts of their isolated domains. Only a few countries—mainly very small ones—either sell over half their production abroad or depend on foreign output for more than half their consumption. This means that most of the world's goods and services are still sold in the countries in which they're produced. Moreover, the principal source of capital in most countries is domestic rather than international.

### 2.1. The Decision in Operations

To achieve the goals of their organizations, managers must understand how decisions are made and know which decision-making tools to use. The success or failure of both people and companies depends on the quality of their decisions. Decisions that lend themselves to display in a decision table also lend themselves to display in a decision tree. We will therefore analyze some decisions using decision trees. Although the use of a decision table is convenient in problems having one set of decisions and one set of states of nature, many problems include sequential decisions and states of nature.

When there are two or more sequential decisions, and later decisions are based on the outcome of prior ones, the decision tree approach becomes appropriate. A decision tree is a graphic display of the decision process that indicates decision alternatives, states of nature and their respective probabilities, and payoffs for each combination of decision alternative and state of nature.

Expected monetary value (EMV) is the most commonly used criterion for decision tree analysis. One of the first steps in such analysis is to graph the decision tree and to specify the monetary consequences of all outcomes for a particular problem.

Analyzing problems with decision trees involves five steps:

1. Define the problem.
2. Structure or draw the decision tree.
3. Assign probabilities to the states of nature.
4. Estimate payoffs for each possible combination of decision alternatives and states of nature.
5. Solve the problem by computing the expected monetary values (EMV) for each state-of-nature node.

This is done by working backward—that is, by starting at the right of the tree and working back to decision nodes on the left.

### 2.2. Linear Programming

Many operations management decisions involve trying to make the most effective use of an organization's resources. Resources typically include machinery (such as planes, in the case of an airline), labor (such as pilots), money, time, and raw materials (such as jet fuel). These resources may be used to produce products (such as

machines, furniture, food, or clothing) or services (such as airline schedules, advertising policies, or investment decisions). Linear programming (LP) is a widely used mathematical technique designed to help operations managers plan and make the decisions necessary to allocate resources. (Heizer & Render, 2014)

Formulating a linear program involves developing a mathematical model to represent the managerial problem (Render, Stair, & Hanna, 2011). Thus, in order to formulate a linear program, it is necessary to completely understand the managerial problem being faced.

The steps in formulating a linear program follow:

1. Completely understand the managerial problem being faced.
2. Identify the objective and the constraints.
3. Define the decision variables.
4. Use the decision variables to write mathematical expressions for the objective function and the constraints.

### 2.3. The Framework Research Model

The framework model in figure 2.1, it can be seen that the maximum profit is affected by two factors. The first one is the combination of products to be produced which are all common, all custom, or combination. This one is going to be solved using Decision Tree. Second one is the type and the quantity of products to be produced based on the output of the first factor. Since the second one will be solved using Linear Programming, the outcome will be considered by the objective functions, alternative course of action, and constraints.

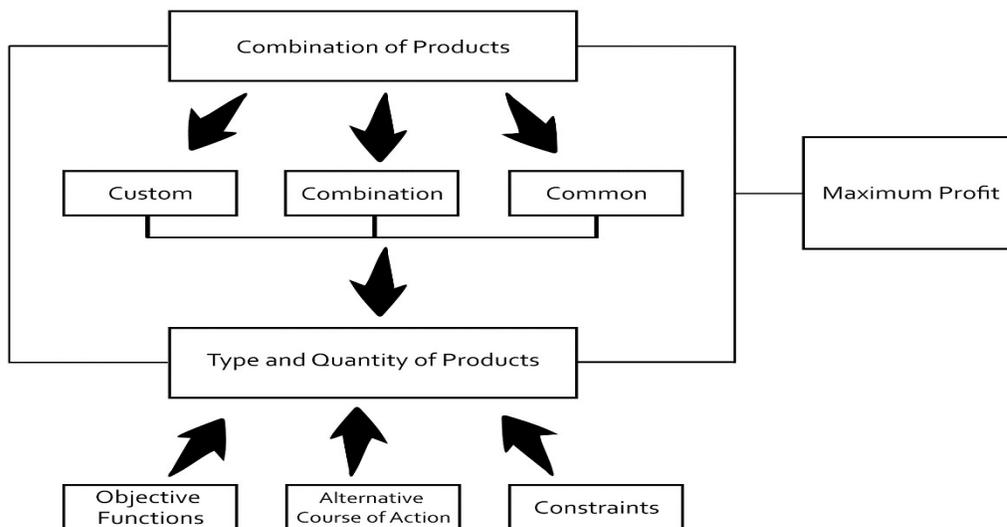


Figure 2.1: Framework Model

## 3. Research Method

The type of the study is descriptive as the goal of this research is to analyze what kind and how many products to be produced to be given as a recommendation towards the company in order to increase their profit. Thus, the research will use cross-sectional studies as the data is only collected once during the research period. All data needed to conduct this study will be from secondary data received from PT. GMS, hence, the research strategies are more likely to be survey.

### 3.1. Analysis Method

In order to process the data obtained, the researcher will use quantitative analysis method. Whereas quantitative analysis method itself is a forecasting method that involves statistical analysis towards the past performance data (Firdaus, 2006). There are two different quantitative analysis methods being used in this research, first is Decision Tree and then Linear Programming. All data analysis is conducted using QM for windows 2.

### 3.2. Decisions Tree

Initially, the researcher needs to find out the most profitable products combination should be chosen by PT. GMS. Whether they want to produce custom products, common products, or combination between them. In order to choose the most profitable decision, the researcher will use Decision Tree. There are three types of decision making which are decision making under uncertainty, decision making under risk, and decision making under certainty. For this case, the researcher will be using decision making under risk as the data to determine the probabilities is provided and the researcher will then visualize it using Decision tree. Therefore, the decision tree formulation can be seen in Figure 3.1.

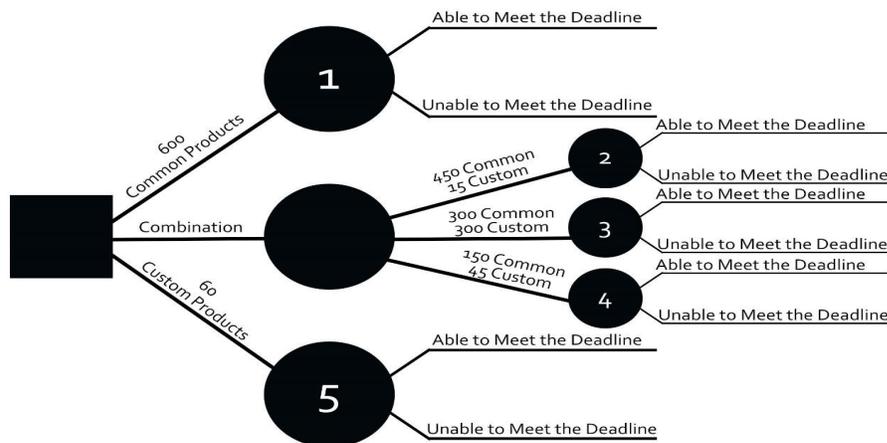


Figure 3.1 Decision Tree Formulation for PT. GMS

There are 5 different alternatives for PT. GMS products' combination, namely:

1. All Common Products. This alternative suggests the company to use their whole capacity to produce common products. It can yield 600 products.
2. 450 Common Products and 15 Custom Products. The ratio is chosen as an average of alternative 1 and 3.
3. 300 Common Products and 30 Common Products. This is their current production ratio.
4. 150 Common Products and 45 Custom Products. The ratio is chosen as an average of alternative 3 and 4.
5. All Custom Products. This alternative suggests the company to use their whole capacity to produce custom products. It can yield 60 products.

Figure 3.1 also shows that there are 2 different states of nature, the first one is the condition whereas the company are able to deliver the products on time, and the second is the condition whereas the company are unable to deliver it on time thus receiving penalties.

### 3.3. Linear Programming

The next step is about allocating resources in the most efficient manner to produce the right type and quantity of products in order to get the maximal profit given by the specific constraints and predetermined objectives. This problem can be solved by using Linear Programming Simplex method.

### 3.4. Implication Planning

After the result are yielded, the researcher will:

1. Compare the profit generated before and after the result is yielded. Before this, the company will always agree on every product's request as long as their quota is still available without thinking about the maximum profit they can get. The result of this research will help them determine whether they want to focus on producing common products, custom products, or combination between them, type of products to be produced in order to allocate the resources in most efficient manner but still get maximum profit, and the quantity of each products that should be produced.
2. Give recommendation of the findings to PT. GMS in order to increase their profit, therefore PT. GMS can use the extra amount of money to expand their business or increase their market's share.

#### 4. Results and Analysis

Decision Tree Model is used to determine which combination of products should be produced by the company in order to get the maximum profit. There are 3 types of decision model which are decision making under uncertainty, decision making under risk and decision making under certainty. For this case, researcher will use decision making under risk with assumed probabilities for each state of nature. PT. GMS has the options whether to produce all custom products, all common products, or the combination between them. The result from this method will then be used for the second analysis using Linear Programming.

There are 5 alternatives for product's decision which are common products, custom products and combination between them. The current capacity is to produce 30 Custom Products and 300 Common products with the condition that the resources (Craftsman, Time, Research, etc.) needed to make 10 custom products can be allocated to make 100 common products, vice versa. Which mean the current capacity can be changed into 600 common products, 60 custom products or combination within that limitation.

Payoffs Data of each possible combination of the decision alternatives and states of nature are received from PT. GMS by calculating their possible profit or loss.

According to this case, first state of nature is a condition by which the chosen decision is the same with the reality or all the products can be delivered on time / no defect products / etc., or so-called "able to meet the deadline" condition. Giving that condition, it is translated to the form of maximum net profit. In order to calculate the net profit, the researcher will first calculate the total revenue obtained for each decision thus multiply them with the net profit margin. The profit margin common products and custom products are 0,3 and 0,65. Thus, for calculating the total revenue, since the products price for common products varies from 85 USD to 520 USD, the researcher will use the average of the price which is 233 USD. As for common products, the price starts from 320 USD.

On the other hand, second state of nature is the condition by which the planned is not working smoothly. For instance, the planned cannot be delivered on time, the products is rejected, etc., or so-called "unable to meet the deadline" condition. Based on the agreement between PT. GMS and the buyer, not on time delivery will get some penalties. Therefore, the profit received is not maximum and even can lead to loss. For calculating it, the researcher will multiply the maximum profit by 50%, as the lowest the company has ever delivered is 50% from the planned (happened in July), then reduce it by the penalty cost. Penalty is calculated by multiplying the price of the products that are not delivered with 15%, in accordance with the agreement. Calculation will be explained in detail below.

It can also be seen in table 4.1 that PT. GMS had 75% on time delivery rate (9 months of on time delivery/12), hence, the researcher will use 0,75 as the probability of "Able to Deliver on Time" and 0,25 (1-0,75) as the probability of "Unable to Deliver on Time". Data regarding each alternative and the outcome for each states of nature can be seen in Table 4.2.

Table 4.1 PT. GMS 2015 Production

Month	Number of Products		Ratio		Status
	Custom	Common	Custom	Common	
Jan	17	400	2	40	On Time
Feb	15	240	2	20	<b>Bellow Target</b>
Mar	31	337	3	30	On Time

Apr	19	352	2	40	On Time
May	23	256	2	30	<b>Bellow Target</b>
June	30	346	3	30	On Time
July	11	215	1	20	<b>Bellow Target</b>
August	38	250	4	30	On Time
Sept	32	330	3	30	On Time
Oct	37	303	4	30	On Time
Nov	38	303	4	30	On Time
Dec	33	408	3	40	On Time

Table 4.2 Decision Table for PT. GMS Product's Decision

No	Alternatives	Probabilities		State of Nature (USD)	
		Able	Unable	Able	Unable
A1	600 Common	0,75	0,25	41.940	10.485
A2	450 Common 30 Custom	0,75	0,25	34.575	9.063,75
A3	300 Common 30 Custom	0,75	0,25	27.210	7.642,5
A4	150 Common 45 Custom	0,75	0,25	19.845	6.221,25
A5	60 Custom	0,75	0,25	12.480	4.800

**Favorable Market Calculation:**

$$A_1 = 600 \times 233 \times 0,3 = 41.940$$

$$A_2 = (450 \times 233 \times 0,3) + (15 \times 320 \times 0,65) = 34.575$$

$$A_3 = (300 \times 233 \times 0,3) + (30 \times 320 \times 0,65) = 27.210 \quad A_4 = (150 \times 233 \times 0,3) + (45 \times 320 \times 0,65) = 19.845$$

$$A_5 = 60 \times 320 \times 0,65 = 12.480$$

**Unfavorable Market Calculation:**

$$A_1 = (41.940 \times 50\%) - (300 \times 233 \times 15\%) = 10.485$$

$$A_2 = (34.575 \times 50\%) - (225 \times 233 \times 15\%) - (7,5 \times 320 \times 15\%) = 9.063,75$$

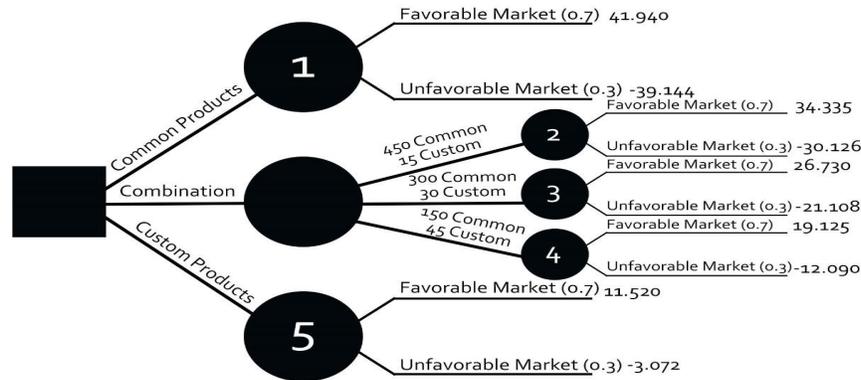
$$A_3 = (27.210 \times 50\%) - (150 \times 233 \times 15\%) - (15 \times 320 \times 15\%) = 7.642,5$$

$$A_4 = (19.845 \times 50\%) - (75 \times 233 \times 15\%) - (22,5 \times 320 \times 15\%) = 6.221,25$$

$$A_5 = (12.480 \times 50\%) - (30 \times 320 \times 15\%) = 4.800$$

**4.1. Decision Tree**

In order to make each possible combination of decision alternatives and states of nature becomes more visible and easier to be understood, the researcher will use decision tree to visualize it. The result can be seen in figure 4.2.



Figures 4.2. Decision Tree for PT. GMS Product's Decision

- Alternative 1. Produce 600 Common Products
- Alternative 2. Produce 450 Common Products and 15 Custom Products
- Alternative 3. Produce 300 Common Products and 30 Custom Products
- Alternative 4. Produce 150 Common Products and 45 Custom Products
- Alternative 5. Produce 60 Custom Products

**Expected Monetary Value (EMV) Calculation**

Expected Monetary Value (EMV) can be calculated by summing all of the possible payoffs from alternatives, each weighted by the probability of payoffs' occurrence. EMV can be used to determine alternatives that can generate highest profit or lowest cost. The result using QM for Windows 2, shows that Alternatives 1 which is 600 common products, has the highest Expected Monetary Value of 34.076,25. Hence, PT. GMS need to stop receiving order for custom products and start focusing their resources and capacity on common products' production.

**4.2. Linear Programming Formulation**

Decision Tree has helped to decide the most profitable products to produce, which is common products, however, there are 6 types of common products dominated PT. GMS's sales and the company needs to determine common product's combination that can generate the maximum profit as well as efficient resource allocation so that nothing will be wasted.

Based on PT. GMS's policy, their products profit margin is 30% of the total price. Therefore, the profit calculation for each PT. GMS's products can be seen in table 4.3

Table 4.3 Profit Data for each common products of PT. GMS

Type	Salontafel (Coffee Table) (A)	Hoektafel (Corner Table) (B)	Vitrine (Showcase Cupboard) (C)	Kast (Wardrobe) (D)	Dressoir (E)	EET (Dining Table) (F)
Price (USD)	180	85	520	192	258	160
Profit Margin 30%	54	25,5	156	57,6	77,4	48

Thus, the objective function of the linear programming models become:

$$54A + 25,5B + 156C + 57,6D + 77,4E + 48F$$

### 4.3. Constraints

In the production process, the company was faced by some constraints as follows:

1. Wood Components. There is a limitation to the amount of wood components that can be used to build the furniture each month. Every month, PT. GMS was able to produce 125 cubic meter wooden components, meanwhile, for each common product, they need 0,1028 cubic meters for Salontafel, 0,062 cubic meters for Hoektafel, 0,285 cubic meters for Vitrine, 0,0925 cubic meter for Kast, 0,1695 cubic meter for DRESSOIR, and 1,2825 cubic meter for EET. Therefore, the wood components constraint equation:

$$0,1028A + 0,062B + 0,285C + 0,0925D + 0,1695E + 0,12825F \leq 125$$

2. Time. Working hour for PT. GMS starts from 7.30 AM to 4.00 PM with one-hour lunch break from Monday to Friday. Assuming that every month consists of 30 days and subtracting it with day offs, the optimum working days will become 24 days. At the moment, there are 36 craftsmen working in furniture assembly division. Making the available hours in production process become 7,5 hours/day \* 24 days \* 36 = 6.480 working hours. It takes 13.2 hours to make Salontafel, 7 hours to make Hoektafel, 13.8 hours to make Vitrine, 13.2 hours to make Kast, 10.2 hours to make DRESSOIR, and 12.6 hours to make EET. Thus, the time constraint equation:

$$13,2A + 7B + 13,8C + 13,2D + 10,2E + 12,6F \leq 6.476$$

3. Container Capacity. There are 3 types of containers sizing provided by company's freight forwarder partner, which are 20 feet (33,1 cubic meters), 40 feet (67,5 cubic meters), and 45 feet (86,1 cubic meters). The current agreement allows them to have 4 × 67.5 feet containers, therefore, the maximum volume they can have currently is 405 cubic meters. Hence, the Container Capacity constraints:

$$0,3528A + 0,1512B + 1,78C + 0,4D + 0,945E + 0,63F \leq 405$$

4. Minimal Products. According to PT. GMS past production plan, the average amount of each products they can deliver per month are as follows; 61 products for Salontafel, 63 products for Hoektafel, 100 products for Vitrine, 72 products for Kast, 65 products for DRESSOIR, and 50 products for EET. These data have set the bottom line for PT. GMS in upcoming production.

So, the constraints equation for each product will become:

$$A \geq 61; B \geq 63; C \geq 100; D \geq 72; E \geq 65; F \geq 50$$

5. Minimum Delivery Based on the result of the Decision Tree, PT. GMS has to produce minimum 600 items each month to maximize their capacity otherwise, their profit will not reach maximum. The constraint equation is:

$$A + B + C + D + E + F \geq 600$$

Linear Programming model of PT. GMS problem in order to get maximum profit will be.

#### Objective Function:

Maximize:  $54A + 25,5B + 156C + 57,6D + 77,4E + 48F$

#### Subject to:

Woods :  $0,1028A + 0,062B + 0,285C + 0,0925D + 0,1695E + 0,12825F \leq 125$

Time :  $13,2A + 7B + 13,8C + 13,2D + 10,2E + 12,6F \leq 6.480$

Containers :  $0,3528A + 0,1512B + 1,78C + 0,4D + 0,945E + 0,63F \leq 405$

Minimum Products:  $A \geq 61; B \geq 63; C \geq 100; D \geq 72; E \geq 65; F \geq 50$

Capacity :  $A + B + C + D + E + F \geq 600$

Where: A = Salontafel, B = Hoektafel, C = Vitrine D = Kast, E = DRESSOIR and F= EET

Using QM for Windows 2 as follows:

Objective		Instruction							
<input checked="" type="radio"/> Maximize <input type="radio"/> Minimize		There are more results available in additional windows. These may be opened by using the WINDOW option in the Main Mer							
PT. Gerraldi Meta Semesta Solution									
	A	B	C	D	E	F		RHS	Dual
Maximize	54.	25.5	156.	57.6	77.4	48.			
Time (Hours)	13.2	7.	13.8	13.2	10.2	12.6	<=	6,480.	0.
Woods (Cubics Meter)	0.1028	0.0626	0.2847	0.0925	0.1695	1.1283	<=	125.	1,073.578
Container Capacity	0.3528	0.1512	1.78	0.4	0.945	0.63	<=	405.	0.
A Minimal	1.	0.	0.	0.	0.	0.	>=	61.	-14.6579
B Minimal	0.	1.	0.	0.	0.	0.	>=	63.	0.
C Minimal	0.	0.	1.	0.	0.	0.	>=	100.	-107.9203
D Minimal	0.	0.	0.	1.	0.	0.	>=	72.	0.
E Minimal	0.	0.	0.	0.	1.	0.	>=	65.	-62.8655
F Minimal	0.	0.	0.	0.	0.	1.	>=	50.	-1,121.559
Minimum Delivery	1.	1.	1.	1.	1.	1.	>=	600.	-41.706
Solution->	61.	238.7559	100.	85.2441	65.	50.		37,323.34	

Figure 4.5 Linear Programming – Result

Calculation using QM for Windows 2 showed that in order to get the maximum profit, PT. GMS needs to produce 61 Salontafel,  $238,76 \cong 239$  Hoektafel, 100 Vitrine,  $85,244 \cong 86$  Kast, 65 Dressoir, and 50 EET. In total, they need to produce 601 items. Thus, the profit that they will get is 37.323,34 USD  $\cong$  **37.323 USD**.

#### 4.4. Proposed Solution

Based on the Linear Programming result, here are some proposed solution in order to make the resources become more efficient:

1. **Time.** There has been 205 hours overtime in PT. GMS per month. Based on the formula to calculate the available working hours itself ( $7,5 \times 24 \times 36$ ), the researcher can get the information that 1 craftsman can contribute 180 hours per month. As a result, the company is still possible to only have 35 craftsmen and still have 25 hours overtime. By doing that the company can save approximately 92,6 USD ( $1 \times 1.300.000 \div 14.040$ ) per month.
2. **Containers.** There has been 42 cubic meters extra in PT. GMS Containers Capacity. The shipping cost for each container are 2.450 USD for 20 feet, 4.375 USD for 40 feet, and 5.340 USD for 45 feet. Previously, the company has been using 4x40 Feet containers. Thus, the shipment cost calculation is  $4 \times 4.375$  USD, resulting the final cost of shipment become 17.500 USD. However, increase in quantity for common products resulted in the space deficiency, so the company needs to increase the number of containers. The proposed containers' plan to handle the shipment is to use 4x45 Feet Containers and 1x20 Feet Containers. Thus, the capacity will become 377.5. And the cost become 23.810 USD.
3. **Woods.** For this case, the binding constraint is Wood. A constraint is considered to be binding if changing it also changes the optimal solution. Proven by the fact that the slack / surplus for this constraint is zero. In conclusion, if PT. GMS wants to increase its production or to grow bigger, the first thing they need to increase its woods supply.

Using the old production plan method, each month will generate the total of 16.093 USD. However, the Linear Programming yields that, if the company only produce 600 common products, each month they can generate 18.661,5 USD ( $37.323 \text{ USD}/2$ ). So, the company can get 2.568 USD additional profit.

The Linear Programming Result is 37.323 USD, however, due to the increasing quantity of products should be produced, PT. GMS needs to add 1 more container and change the capacity of the old containers, resulted in increased cost for 6.310 USD ( $23.810 \text{ USD} - 17.500 \text{ USD}$ ) each month.

$$37.323 \text{ USD} - 21.785,5 \text{ USD} - 6.310 \text{ USD} = 9.227,5 \text{ USD}$$

Therefore, the additional net profit PT. GMS can obtain each month is 9.227,5 USD.

## 5. Conclusion and Recommendation

### 5.1. Conclusion

The research's result shows that even though custom products have a bigger profit margin, it does not mean that producing them will yield the maximum profit as it tends to use more human resources and take longer time to produce. Based on the result of Decision Tree, it is better for PT. GMS to only focus on using their capacity to produce **600 common products** instead of using its current capacity (30 custom products and 300 common products).

Since there are 6 type of common products that dominates the sales of PT. GMS, the Linear Programming is then used so find the optimum products's type to produce. As a result, PT. Gerraldi Mena Semesta needs to produce 61 Salontafel,  $238,76 \cong 239$  Hoektafel, 100 Vitrine,  $85,244 \cong 86$  Kast, 65 DRESSOIR, and 50 EET. Thus, the profit that they will get is 37.323,34 USD  $\cong$  **37.323 USD**.

Linear Programming also shows that PT. GMS can change the amount of time and containers they used in order to be more effective. Therefore, after subtracting the changing containers' cost and the current production's profit to the Linear Programming Result, the net profit increment PT. GMS can obtain each month is 9.227,5 USD.

### 5.2. Recommendations

Based on the result, here are some recommendation for PT. GMS:

1. Binding constraint for PT. GMS is woods. Therefore, if they want to increase their production, the first thing that they need to consider is increasing the amount of woods they are going to bought.
2. If PT. GMS wants to, they can allocate 1 human resource in product's assembly division to other division as there are some surplus in time. However, since the amount of money being reduced by it is not significant, it is not necessary for the company to do.
3. Further calculation in Production Plan is needed so that the company will know what to be produced each day and when should they start to produce a type of product. It is very critical because the research's calculation is only applicable if the company managed to achieve the production's target.

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